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**REMEDIAL DESIGN WORKPLAN
FOR THE
WHITE KING / LUCKY LASS MINES
SUPERFUND SITE**

Submitted to:

*U.S. Environmental Protection Agency
Region X
Seattle, Washington*

Submitted by:

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1.0 INTRODUCTION

This document is the Remedial Design Workplan for the White King / Lucky Lass Mines Superfund Site, near Lakeview, Oregon. This Workplan is prepared to describe the approach to be used in conducting remedial design activities by the White King / Lucky Lass Site Group, which consists of Kerr-McGee Chemical Worldwide LLC. (KMCW LLC), Western Nuclear Inc., and Fremont Lumber Company ("Site Group").

1.1 Background

The White King / Lucky Lass Mines Superfund Site (Site) is located in south-central Oregon, approximately 17 miles northwest of Lakeview, Oregon (Figure 1-1). The Site consists of two former uranium mines, located within one mile of each other (Figure 1-2). Portions of the Site are within the Fremont National Forest, managed by the United States Forest Service (USFS), and portions are on private lands owned by Fremont Lumber and the Coppin family trust.

Major features at the White King Mine include the White King Pond (formed when water collected in an open-pit mine), the so-called "protore stockpile", and the "overburden" stockpile. Both stockpiles are actually overburden material. The pit pond occupies approximately 13 acres and contains about 80 million gallons of water. The two stockpiles contain a combined volume of almost one million cubic yards of material.

Augur Creek runs south through the eastern side of the White King Mine area, and receives discharge from the White King Pond.

Major features at the Lucky Lass Mine include the Lucky Lass Pond and the overburden stockpile. This pond covers approximately 5 acres. The Lucky Lass overburden stockpile covers about 14 acres and contains approximately 260,000 cubic yards of material.

1.1.1 Site History

The White King and Lucky Lass uranium deposits were discovered in mid-1955. The local individuals who made the discoveries conducted exploratory work and some mining. Mining began in earnest after Garth and Vance Thornburg leased both mines in September 1955, and then assigned those leases to Lakeview Mining Company (Lakeview Mining) in March 1956.

Lakeview Mining began significant underground ore production in 1958 at the much larger White King Mine. In April 1959, Lakeview Mining converted the White King Mine to open pit mining. This conversion placed the overburden in its present stockpiled location and created the pit that became the White King Pond. Open-pit mining at the White King Mine continued until December 1959. Open-pit mining commenced at the Lucky Lass Mine in 1956.

Lakeview Mining discontinued commercial operations at both mines by early 1960. After 1961, sporadic small-scale mining conducted by others continued at both mines through 1964. Exploration activities at the site occurred through the early 1980s.

The Site was listed on the National Priorities list on April 25, 1995 as a Federal Facility. At the time of listing, the United States Environmental Protection Agency (EPA) stated, "The AEC oversaw mining operations." Remedial investigation and feasibility study (RI/FS) activities were conducted at the Site by Kerr-McGee Corp. from the summer of 1995 through 1999.

Kerr-McGee Corporation conducted a Remedial Investigation (RI) and Feasibility Study (FS) under Superfund procedures and guidelines pursuant to an Administrative Order on Consent. The RI Report was finalized in 1997 (Weston, 1997) and the FS Report was finalized in 1999 (Weston, 1999a). Additional site reports are listed in the FS. The EPA issued a Record of Decision (ROD) on September 30, 2001.

1.1.2 Prior Site Reports

A Draft Environmental Impact Statement Remedial Investigation/Feasibility Study for the Cleanup and Rehabilitation of the White King and Lucky Lass Uranium Mines (DEIS) was prepared by/for the United States Forest Service (USFS) in August 1991, and a revised DEIS was issued in 1994. Upon review of the 1994 DEIS-RI/FS Report, EPA determined that further investigation and analysis of remedial alternatives was needed to support a remedial action decision under CERCLA. Kerr-McGee Corporation conducted an RI and a FS under Superfund procedures and guidelines pursuant to an Administrative Order on Consent. The RI Report was finalized in 1997 (Weston, 1997) and the FS Report was finalized in 1999 (Weston, 1999a). Additional site reports are listed in the FS.

1.2 Purpose and Scope

The purpose of this Workplan is to describe the process for engineering design associated with the remediation of the White King / Lucky Lass Mines Superfund Site. Specifically, this Workplan will describe administrative aspects of the design process, identify data needed to complete the design and the approach for obtaining these data, and discuss the deliverables that will be produced during the design process.

This Workplan is primarily oriented toward the earthwork activities at various locations around the Site as described in the ROD (EPA, 2001).

1.3 Design Objectives

The ROD listed remedial action objectives (RAO) for both the White King and Lucky Lass areas. These RAOs are:

- Reduce exposure to stockpiles and contaminated off pile soil.
- Reduce and eliminate the release of contaminants from soils to groundwater or surface water to protect for beneficial uses.
- Prevent removal or use of overburden soils.
- Prevent direct contact with contaminated soils at Lucky Lass.
- Prevent future use of stockpile soils with contaminant concentrations in excess of protective levels.

To meet those RAOs, the remedial design (RD) objectives for this project are:

- Recontour the White King protore stockpile so that it is no longer within the Auger Creek floodplain. The ROD estimates that this will require moving approximately 138,000 cy of stockpile soil.
- Excavate the White King Mine haul road, a portion of the Lucky Lass stockpile, and certain off-pile areas where there is evidence of mine-related waste above cleanup levels, and place these materials on the recontoured protore stockpile. The areas and quantities to be excavated will be determined by the off-pile survey described in this workplan.

- Excavate the White King overburden stockpile, which consists predominantly of clay-like material, and place it on the recontoured protore stockpile to form a low-permeability layer. The ROD estimates approximately 465,000 cy of will be excavated.
- Place 18 inches of cover soil and 6 inches of topsoil on the consolidated stockpile surface sufficient to support vegetation, and seed the topsoil surface.
- Place 3 inches of topsoil and reseed those areas where soil has been removed.

Other objectives of the design process will be to recommend appropriate institutional and physical access controls for both White King and Lucky Lass to prevent undesirable uses.

1.4 Summary of Existing Data and Conclusions

The primary sources of existing data and conclusions are the RI Report (Weston, 1997) and the FS Report (Weston, 1999a). Selected relevant information is summarized below at a level of detail to place the additional data needs described in Section 3 in context.

1.4.1 Soils

In the ROD, the EPA selected soil cleanup levels for the following indicator constituents of concern (COCs): arsenic (As) and radium-226 (Ra-226). For the White King Mine, these cleanup levels are 442 mg/kg for arsenic and 6.8 pCi/g for Ra-226. For the Lucky Lass Mine, these cleanup levels are 38 mg/kg for arsenic and 3.6 pCi/g for Ra-226. The EPA determined that use of these indicator parameters provides sufficient cleanup of other COCs.

The FS (Weston, 1999a) provided a number of figures summarizing RI sampling results; several of these figures are provided in Appendix A of this workplan. Arsenic concentrations (surface and subsurface) for the Site are shown on FS Figures 1-7 and 1-8. Ra-226 concentrations for the Site are shown on FS Figures 1-9 and 1-10.

Based on RI data, the mine-related waste materials are primarily in the three stockpiles (two at the White King Mine and one at Lucky Lass). Some additional mine-related wastes may be present outside of these stockpiles.

1.4.2 Naturally Occurring Mineralization

A series of letter reports were prepared by Kerr-McGee Corporation and Weston addressing the issue of background levels (natural soil concentrations) at the Site. The Site is located in the Lakeview Uranium District along with numerous other uranium occurrences and prospects (i.e., potential areas where ore could still be found). In many cases, surface expression of uranium mineralization led to the discovery of these occurrences and prospects. As a result of natural soil formation processes, soils in the vicinity of uranium mineralization may contain levels of uranium-series radionuclides and other associated elements reflective of these occurrences and prospects today at locations which have never been affected by placement of overburden or its weathering.

The letter reports prepared by Kerr-McGee and Weston documented the levels of arsenic and Ra-226 in a variety of soil, rock, and sediment samples in the general vicinity of the Mines Site. More specifically, the reports document elevated levels of arsenic and Ra-226 in White King meadow soils that are likely naturally occurring. Arsenic levels up to 1,570 mg/kg and Ra-226 levels up to 9.9 pCi/g have been identified in White King Meadow soils. These values represent the upper end of the

range of naturally occurring soil background levels, based upon current information. Therefore, even though the levels identified by Kerr-McGee and Weston were not used by EPA to set cleanup levels within the piles, these data are still relevant for identification of off-pile mine-related waste.

Means of identifying natural mineralization are described in Section 3.

1.4.3 White King Stockpiles

The physical properties of soils in both White King stockpiles were evaluated as part of the FS (Weston, 1999a). Laboratory test results are reported in the *Treatability Study* (Appendix A of the FS), and additional laboratory and field test results for the “overburden” stockpile are presented in the *Material Handling Report* (Appendix B of the FS).

Mineralogical analysis concluded that the materials in both stockpiles are essentially the same, and this conclusion is supported by geotechnical index tests (FS Appendix A, Section 4). On this basis, testing results for the “protore” stockpile are considered applicable to the “overburden” stockpile.

Existing data pertinent to remedial design is discussed in Section 3 and is briefly summarized here. Of particular relevance for remedial design is the permeability of the clay-like materials. Hydraulic conductivity was measured on undisturbed samples from the “protore” and “overburden” stockpiles and from test pads constructed to evaluate soil placement methods. The results are shown on Figure 3-2, plotted against the initial moisture content and density of the test specimens. These results indicate that the stockpile soils can achieve relatively low permeabilities over a wide range of moisture and density conditions.

Natural moisture contents for both stockpiles are also shown on Figure 3-2. Note that these data are plotted along a line corresponding to 75% relative density, solely for convenience to show these data on the same graph. These data indicate that the soil materials in the overburden stockpile in their existing moisture condition should be able to achieve permeabilities on the order of 10^{-7} to 10^{-8} cm/sec when excavated and recompacted on the consolidated stockpile. Furthermore, it can be assumed with a high degree of confidence for design purposes that these permeability values represent the upper limit of the undisturbed, in-place stockpile soils.

As part of the material handling study, an excavation and placement demonstration was performed using scrapers and sheeps-foot compactors. This activity showed that the overburden stockpile soil was workable just as it came from the pile, and could be effectively placed and compacted with standard construction equipment.

1.4.4 Lucky Lass Stockpile

The physical (i.e., geotechnical) properties of the Lucky Lass stockpile have not been investigated. Based on field observations during the June 18, 2003, site visit it is reasonable to assume that they will be generally similar to those of the White King stockpiles. Because all but a small percentage of these soils have COC levels below the selected soil cleanup levels, the volume of soil that is anticipated to require removal from this stockpile is relatively small. Consequently, only a minor characterization of the physical properties of this material is planned.

With respect to COCs, the RI in Section 4.3.3 notes that the Lucky Lass stockpile has “significantly less” concentrations of metals than the White King stockpiles, and concludes that “the Lucky Lass stockpile contains very small amounts of radionuclides and metals.” The ROD summarizes these

results in Table 5-3, indicating that the highest concentration of arsenic in the stockpile was 11.9 mg/kg measured at the surface, while the average concentration from depths of 2.5 to 10 feet was 3.7 mg/kg. For Ra-226, the highest individual surface measuring was 4.85 pCi/g (see FS Figure 1-10 in Appendix A) and at depth, 8.3 pCi/g (see FS Figure 1-10 in Appendix A). As listed in Table 5-3, Ra-226 had an average activity of 2.0 pCi/g from depths of 2.5 to 10 feet.

2.0 REMEDIAL DESIGN MANAGEMENT

2.1 Project Organization and Key Personnel

The White King / Lucky Lass Site Group has retained Golder Associates Inc. (Golder), the U.S. operating company of Golder Associates, to perform the remedial design and supporting studies for the Site. Golder Associates is an international group of employee-owned, consulting engineering companies specializing in the technical fields of site remediation, environmental engineering, soil and rock engineering, engineering geology, and hydrogeology. Golder Associates is one of the world's leading mining consultants, with extensive experience in mine site remediation. This project will be staffed primarily out of the Golder Redmond, Washington, office. Over 100 technical professionals are resident in this office, supported by full CADD, GIS, and other design support personnel. Additional sediment studies described in the White King Pond and Augur Creek Study Workplan will be supported by specialists from Golder Associate's Calgary and Saskatoon offices.

The key personnel for this project are shown in the project organization chart (Figure 2-1). Resumes of key personnel are provided in Appendix B.

2.2 Remedial Design Deliverables

The remedial design process will involve a number of deliverables. Draft documents will be submitted to EPA, USFS, Oregon Department of Environmental Quality (ODEQ), Oregon Office of Energy (OOE), and (if an appropriate contact is identified by the U.S. government) the U.S. Department of Energy (successor to the Atomic Energy Commission) for review. Once all comments have been received in writing from those agencies that elect to submit comments, the Site Group will provide appropriate responses to the comments. These responses will be discussed with the agencies in a telephone conference or, if deemed necessary, a meeting at the EPA's office in Seattle, Washington. Upon completion of the comment resolution process, the draft documents will be revised incorporating agreed-upon changes. This workplan satisfies the initial tasks EPA has set out in overall work for the Site.

Documents will be submitted at several points during the design process, following the schedule in Section 2.3. These include the 30% Design, Preliminary Design, and Final Design. Because various documents depend on each other, they will be at differing stages of completion during each phase of the design process. However, by the end of the remedial design process, the following specific deliverables will be prepared:

2.2.1 Field Investigation Report

The Field Investigation Report will describe sampling methods, sample locations, and results of the field investigation activities described in this workplan. An outline of this report is provided in Appendix C.

2.2.2 Design Report

The Design Report will describe the features of the remedial design in detail, and will serve as an umbrella document for the drawings, specifications, and other construction documents. The Design Report will describe each major feature of the remedial activity, and indicate how the design satisfies the requirements of the ROD. Key design calculations will be included as an appendix. An outline of the Design Report is included in Appendix D.

2.2.3 Design Drawings

Construction drawings suitable for bidding will be prepared. Drawings will be D size (34" x 22"), which allows for reduction to half-size at 11" x 17" for review purposes.

A preliminary list of construction drawings is shown in Table 2-1. This list was developed based on project requirements and our experience with work of this type, and includes the critical elements typically required. This list may change as the project evolves.

2.2.4 Technical Specifications

Technical specifications suitable for bidding will be prepared in Construction Specifications Institute (CSI) 3-part format. To the extent practical, these will incorporate existing specifications prepared by Golder, the U.S. Army Corps of Engineers, and other entities. For standard project requirements, particularly Division 1 (Administrative) sections, we will use existing material from the Site Group.

A preliminary list of Technical Specifications is shown in Table 2-2. This list was developed based on project requirements and experience with work of this type, and includes the critical elements that are typically necessary. This list may change as the project evolves.

2.2.5 Draft Construction Quality Assurance Plan

A draft Construction Quality Assurance (CQA) Plan will be prepared. This plan will establish the testing and observation requirements that would be needed during remedial construction. It will also address responsibility and authority, personnel qualifications, documentation, changes and clarifications, and other administrative requirements. An outline of the CQA Plan is presented in Appendix E.

2.2.6 Draft Inspection, Monitoring, and Maintenance Plan

A draft Inspection, Monitoring, and Maintenance (IM&M) Plan will be prepared. This plan will establish inspection procedures for the consolidated stockpile, revegetated areas, diversion ditches, fences, and other permanent project features. Maintenance procedures will be established in general terms for various adverse conditions. The IM&M Plan will also include a Water Quality Monitoring Plan for surface and groundwater and supporting documents such as field sampling and laboratory analysis plans. The IM&M Plan will establish inspection and monitoring frequencies for all activities, and will address reporting requirements.

2.2.7 Capital Construction and IM&M Cost Estimate

A cost estimate for capital construction and IM&M activities will be prepared and submitted as part of the design documents.

2.3 Schedule

The proposed schedule for remedial design work is provided in Figure 2-2.

Table 2-1. Preliminary List of Construction Drawings

Drawing Title	Comments
Cover Sheet	Include project location map
General Notes and Symbols	
Site Features	Include limits of work, stockpile identifications, laydown areas
Survey Control	Show existing monumentation
Existing Topography – Lucky Lass Stockpile	Indicate removal area
Existing Topography – White King Overburden Stockpile	
Existing Topography – Protore Stockpile	
Off-Stockpile Soil Removal Plan	Areas and depths, with control points; include haul road
Final Grades – Lucky Lass Stockpile	
Final Grades - White King Overburden Stockpile Area	
Final Grades – Consolidated Stockpile	
Consolidated Stockpile Sections and Details	
Access Roads – Plan	
Access Roads – Profiles	
Access Roads – Sections and Details	
Erosion Control – Plan	
Erosion Control – Details	
Surface Water Management Plan – Lucky Lass Area	
Surface Water Management Plan – White King Area	
Surface Water Management Details	
Subsurface Interceptor Trench	If required
White King Pond Highwall Seeps	Plan and Details, if required
Restoration Area Plan	Grading / seeding requirements for specific areas, may require several sheets, may include topsoil borrow area
Fencing Plan	
Fencing Details	

Table 2-2. Preliminary List of Technical Specifications

Section No.	Title	Comments
01010	Summary of Work	Include construction sequence and schedule
01050	Surveying	
01060	Health and Safety	Reference H&S Plans
01100	Environmental Protection	Include permit conditions
01300	Submittals	Include project record requirements, as-builts
01400	Quality	Reference CQA Plan
01510	Temporary Facilities	
02110	Clearing and Grubbing	
02220	Earthworks	Excavation, placement, borrow sources, stockpile management for all soil materials, including overburden, existing stockpile soil, clay cover, clean cover soil, armor rock, ditch lining
02270	Erosion Control	Cross-reference 01100
02505	Access Roads	Include surface course, culverts
02830	Fencing	
02930	Restoration	Regrading, positive drainage, seeding

3.0 DATA NEEDS AND FIELD SAMPLING PLAN

This section identifies the data needed for remedial design, and describes the data quality objectives (DQOs), field procedures and analytical methods that will be used to obtain these data. The Quality Assurance Project Plan (QAPP) is provided as Appendix F.

3.1 Gamma Radiation Correlation to Ra-226 Concentrations

3.1.1 Problem Statement

What are the correlations for differing site areas between Ra-226 concentrations (pCi/g) and gamma radiation detected by the gamma survey instrumentation?

3.1.2 Identification of Decision

In order to perform the gamma radiation survey (Section 3.2), it is first necessary to determine the site-specific correlations for differing site areas between Ra-226 concentrations (pCi/g) and gamma radiation detected by the gamma survey instrumentation (Ludlum Model 2221 or equivalent). The correlation study will allow determination of Ra-226 concentrations from gamma survey data.

Separate correlations will be developed for different areas that will be included in the gamma survey (Section 3.2). These will include:

- White King area soils from near the base of the protore stockpile
- White King area soils from the middle of the meadow (between protore stockpile and the haul road)
- Areas adjacent to Augur Creek between the two White King stockpiles
- Lucky Lass soils from near the base of the Lucky Lass stockpile.

If field observations during the correlation work indicate that other areas have significant potential, in the opinion of the field personnel, to have different gamma correlations from the above areas, then additional correlations may be developed for these areas.

3.1.3 Sampling and Analysis Program

The procedures in this section will be repeated for each correlation to be developed.

The correlation target area will be divided into 10-meter-square subareas. Soil samples will be obtained from 10 of these subareas, selected at random. Approximately equal soil quantities will be obtained from each subarea, such that the total soil volume will fill a container at least 4 ft diameter and 8 inches deep. The soil will be homogenized as it is placed in a container on-site using a portable cement mixer or equivalent. The gamma survey instrument will be placed a fixed distance above the center of the container for a minimum of 10,000 counts, and the measurement recorded.

In addition, a separate container of approximately the same dimensions will be filled with clean sand. This container will be placed in at least three (3) varying locations from the nearest stockpile. For each location, the gamma survey instrument will be placed above the center of the container for a minimum of 10,000 counts, and the measurement recorded.

"The boundary of the Augur Creek correlation area will be 10 meters on either side of the edge of the creek along its length within the White King area (see Figure 3-1).

The boundary between the "near stockpile" and "meadow" correlation areas at White King will be determined in the field using professional judgment based on field observations of the soil materials and on the results of the sand container measurements. The intent will be to divide the areas such that significant radioactive "shine" effects from the piles are restricted (to the extent practical) to the "near stockpile" correlation area. However, the "near-stockpile" area will be at least 10 meters wide along the base of the stockpiles."

Seven (7) samples of the homogenized soil will be obtained for chemical analysis from different locations within the container. The samples will be sent to a qualified commercial laboratory for analysis. The samples will be analyzed by gamma spectroscopy for Ra-226, thorium-232 (Th-232), potassium-40 (K-40), and their degradation products.

Using the calibration procedure in Appendix G, the gamma survey instrument will be calibrated before the survey measurements using 10 pCi/g Ra-226 calibration blocks traceable to the National Institute of Standards and Technology (NIST) and using blank (0 pCi/g) blocks.

During the fieldwork, daily checks will be performed using the check procedures in Appendix G. The daily checks serve to verify that the gamma equipment is performing within acceptable tolerances.

3.1.4 Study Boundaries

Correlations will be developed for site soils within the gamma radiation survey study boundaries (see Section 3.2.4).

3.1.5 Decision Rule

For each correlation to be developed:

1. The average (mean) and standard deviation of the Ra-226 concentrations for the soil samples will be averaged.
2. Outliers will be considered values that differ from the mean value by more than 3 standard deviations.
3. The average and standard deviation will be recalculated without outliers, and outlier rejection repeated until there are no outliers.
4. A linear correlation will be determined using the average Ra-226 concentration of the soil samples (after outlier rejection), the associated field gamma radiation measurements, the calibration block measurements, and (if necessary) the sand/background measurement.

If two correlations appear very similar, then the data will be analyzed using the t-test with the null hypothesis at the 95% confidence interval that the two data sets are statistically not different. If appropriate based on this analysis, a single correlation may be developed to use for both areas.

The minimum detectable activity (minimum detectable Ra-226 concentration) will be determined for each soil area in conformance with NRC Reg. Guide 4.14. The correlation will be considered usable if the minimum detectable Ra-226 concentration is below the applicable cleanup level.

3.1.6 Decision Error Limits

The decision error limits are the statistical criteria in the decision rule.

3.2 Off-Pile Survey

3.2.1 Problem Statement

What "off-pile" areas (areas outside of existing mine waste stockpiles) contain mine-related waste (not natural mineralization) requiring removal to the consolidated stockpile? These materials are present outside of the stockpiles either by placement during mining or by erosion from the stockpiles.

3.2.2 Identification of Decision

The ROD specifies that mine waste materials away from the stockpiles at the White King and Lucky Lass mine sites that exceed cleanup levels are to be removed and placed on the consolidated stockpile. Results of the gamma radiation survey will be used in remedial design to determine extent of off-piles soils to remove to the consolidated stockpile.

3.2.3 Sampling and Analysis Program

The gamma survey instrument will be calibrated before the survey measurements using the calibration procedure in Appendix G. During the fieldwork, daily checks will be performed using the check procedures in Appendix G. The daily checks serve to verify that the gamma equipment is performing within acceptable tolerances.

Survey measurement locations will be determined using global positioning system (GPS) equipment. The GPS calibration and operations procedures in Appendix H will be followed.

The survey will be conducted along approximately parallel lines extending perpendicularly away from the three existing stockpiles. For Augur Creek, survey lines will approximately parallel Augur Creek. The Augur Creek survey area will extend 10 meters from each edge of the creek. Where stockpile survey lines and Augur Creek survey lines intersect, the Augur Creek lines will be followed for the survey. The parallel lines will be approximately one (1) meter apart. The survey personnel will walk with the gamma survey instrument at a speed of 1-2 miles/hour (determined using GPS). The instrumentation will automatically record the location, date, time, and count-rate every 2 seconds.

Each line will be extended until the measurements indicate that the soil consistently meets the cleanup level, based on the applicable correlation developed as described in Section 3.1

3.2.4 Study Boundaries

The survey will begin at the edges of the existing two White King stockpiles and the Lucky Lass stockpile and extend out radially until the data indicate that soils meet the applicable Ra-226 cleanup levels. The survey will also extend 10 meters on either side of Augur Creek in the vicinity of the two existing White King stockpiles. In addition, two clearing areas potentially impacted by mining

(shown on Figure 3-1) will be included in the survey. The maximum areal extent expected for the gamma survey is shown on Figure 3-1.

3.2.5 Decision Rule

Off-pile areas with soils above the applicable Ra-226 cleanup levels will be determined based on the gamma radiation survey results. The gamma survey data will be converted to pCi/g for comparison to Ra-226 cleanup levels using the applicable site-specific correlation (see Section 3.1).

Prior to the survey, the survey areas will be subdivided using 10-meter-square grids (100 m² subareas) and documented on topographic maps. The survey data will be imported into a graphic information system (GIS). The GIS will then be used to calculate the gamma count averages of the 10-meter-square grids. If the grid average exceeds the applicable cleanup level, then the entire grid area will be considered for removal. In addition, if the average of any 30 adjacent measurements exceeds three (3) times the applicable cleanup level, then the area represented by those measurements will also be considered for removal. "Considered for removal" means that the design will determine the extent of soil to remove within each affected grid area such that, after removal, all of the affected grid areas will meet the cleanup level. For relatively uniform contamination, this means that soil will be removed from the entire grid area. However, if the grid contains a localized "hot spot", then removal of the "hot spot" may be sufficient to achieve the cleanup goal."

It is expected that some natural mineralization will be encountered in the survey areas. Material outside the stockpiles will be considered natural mineralization, and not mine-related waste to be removed, if:

- The material is visually distinct from surrounding soils and extends more than one foot below the ground surface, or
- The material is visually distinct from stockpile soils and is not part of a pattern of elevated radioactivity extending from a stockpile (i.e., the evidence is that the material did not erode from a mining stockpile).

3.2.6 Decision Error Limits

The decision error limits are the statistical criteria in the decision rule.

3.3 Geotechnical Data Collection – General Procedures

Much of the geotechnical data required for design will be obtained by excavating test pits and collecting bulk samples. The general procedures for these activities will be the same regardless of the purpose of the investigation, and are as follows.

Test pits will be excavated to depths up to about 15 feet using a rubber-tired backhoe. Samples will be collected and test pits logged (including photographs) by Golder personnel in accordance with Golder Procedures TP 1.2-21 *Geotechnical Test Pit Logging & Sampling* and TP 1.3-1 *Geologic Mapping of Soils Exposed in Test Pits* (in Appendix I). Number and locations of test pits are described in the following sections. In all cases, if the actual conditions appear to vary significantly, the number of test pits may be increased. Test pits will be located in a uniform distribution throughout the investigation area, subject to local access and other factors. Upon completion, all test pits will be backfilled and then flagged for location with GPS survey equipment. Test pits will also be documented photographically.

Bulk samples for geotechnical testing will be collected in 5-gallon buckets; samples for moisture content testing will be collected in small plastic jars. Samples for chemical analysis will be collected in accordance with Golder Procedures TP 1.2-18 *Sampling Surface Soil for Chemical Analysis* and TP 1.2-23 *Chain of Custody* (in Appendix I). Bulk samples may be collected from soil excavated from test pits or by hand-shovel excavation.

3.4 Volumes for the Consolidated Stockpile

3.4.1 Problem Statement

What are the volumes of material that will be added to the existing protore stockpile to form the consolidated stockpile? This information will be required to prepare grading plans for the consolidated stockpile.

3.4.2 Identification of Decision

The problem will be addressed by estimating the following quantities of soil materials:

- Volume of the White King "overburden" stockpile.
- Volume of the portion of the White King "protore" stockpile to be moved out of the Augur Creek floodplain.
- Volume of the haul road.
- Volume of White King off-pile soils to be moved to the consolidated stockpile.
- Volume of Lucky Lass off-pile soils to be moved to the consolidated stockpile.
- Volume of the Lucky Lass stockpile to be moved to the consolidated stockpile.

3.4.3 Sampling and Analysis Program

This information will be developed based on: (1) volume analyses based on topographic data developed in 2000, and (2) the results of the off-pile survey described in Section 3.2.

3.4.4 Study Boundaries

The features that will be evaluated to calculate the consolidation volumes are identified on Figure 3-1 and Drawing 2 in Appendix J.

3.4.5 Decision Rule

The pre-conceptual design (Appendix J) suggests that the proposed footprint for the consolidated stockpile has a capacity approximately 20% greater than the presently identified requirements. Therefore, if the upper limit of the estimated volumes is within this 20% factor, the capacity of the consolidated stockpile will be considered adequate for the project. The design will indicate that the upper portion of the pile will be developed only as required, and the design will include requirements for grading and drainage to be applied at the final elevation.

3.4.6 Decision Error Limits

Volumes measured from the 2000 topographic data will be calculated using the average end area method with AutoCAD. The uncertainty of these calculations is typically 5% or less.

3.5 **Consolidated Stockpile Shear Strength**

3.5.1 Problem Statement

What is the shear strength of the combined soils? This information will be required for slope stability analyses during design, to ensure that the proposed side slopes will be stable.

3.5.2 Identification of Decision

If the proposed side slopes on the consolidated stockpile do not exhibit adequate stability, the slopes will be reduced to obtain acceptable stability.

3.5.3 Sampling and Analysis Program

Minimum shear strength parameters will be calculated by back-analysis of existing stockpile slopes, which have been stable for at least 40 years, based on visual observations during the June 18, 2003, site visit.

3.5.4 Study Boundaries

The steepest slopes in the existing protore, overburden, and Lucky Lass stockpiles will be analyzed to estimate minimum shear strength parameters.

3.5.5 Decision Rule

Slope stability will be considered acceptable if a factor of safety of 1.5 or greater is obtained using standard, industry-accepted analysis methods.

3.5.6 Decision Error Limits

The lowest calculated shear strength values will be used in the stability analysis of the consolidated stockpile. The minimum factor of safety of 1.5 reflects industry practice to accommodate uncertainty in material properties and other factors.

3.6 **Consolidated Stockpile Compaction Characteristics**

3.6.1 Problem Statement

Two closely related questions are:

- What are the compaction characteristics of the combined soils?
- What is the existing moisture content of the combined soils?

This information will be required to prepare the specification for soil placement and to provide data for potential bidders, respectively.

3.6.2 Identification of Decision

Soil permeability is related to the degree of compaction and the moisture content during compaction. There are no explicit permeability requirements in the ROD for soils placed in the consolidated stockpile, only the description that they will form a "low permeability layer" (ROD Section 12.2.1, second bullet, page 12-3). The attenuation modeling described in the *Treatability Study* (TS, Weston, 1999, *Final Feasibility Study, Volume II, Appendix A: Treatability Study – Characterization and Leachability of Stockpiled Materials*), which indicated negligible impacts to downgradient groundwater from stockpile leaching (TS page 1-2), assumed a hydraulic conductivity value of 1×10^{-6} cm/sec for stockpiled soils (TS Table 3-9). This value is therefore considered the target hydraulic conductivity for soils placed in the consolidated stockpile.

3.6.3 Relevant Existing Data

Data on the relationship between hydraulic conductivity and compaction, as well as natural moisture content, was obtained for both the *Treatability Study* and the *Material Handling Report* (MHR, Weston, 1999, *Final Feasibility Study, Volume II, Appendix B: Material Handling Report*). These data are summarized in Table 3-1.

The hydraulic conductivity results indicate that the soils from both stockpiles achieved the target permeability over all moisture and density conditions tested. The data also indicate lower permeability values at higher moisture contents, as expected for clayey soils. The natural moisture content data indicates that no moisture conditioning will be required during construction, provided that the construction methods do not cause excessive wetting or drying.

Table 3-1. Existing Hydraulic Conductivity Data

Relative Density ^(a)	Relative Moisture ^(b)	Hydraulic Conductivity (cm/sec)	Reference
Protore Stockpile			
90%	-2%	4×10^{-7}	TS Table 4-1
95%	+2%	2×10^{-7}	TS Table 4-1
Overburden Stockpile			
90%	-2%	1×10^{-6}	TS Table 4-1
95%	+2%	8×10^{-7}	TS Table 4-1
Test Pads			
80%	+22%	3×10^{-8}	MHR Attachment C Table 1 ^(c)
84%	+16%	1×10^{-8}	MHR Attachment C Table 1 ^(c)
86%	+10%	5×10^{-7}	MHR Attachment C Table 1 ^(c)

(a) Relative to maximum dry density determined in accordance with ASTM D1557.

(b) Relative to optimum moisture content determined in accordance with ASTM D1557.

(c) Relative density and moisture calculated using compaction curves in MHR Attachment C, Plates 2, 12, and 9, respectively.

Natural moisture contents are summarized in Table 3-2:

Table 3-2. Existing Natural Moisture Content Data

Natural Moisture Content^(a)	Reference
Protore Stockpile	
+12%	TS Table 4-1
+12%	MHR Table 3-2
+8%	MHR Table 3-2
+11%	MHR Table 3-2
+5%	MHR Table 3-2
+8%	MHR Table 3-2
+10%	MHR Table 3-2
Overburden Stockpile	
+11%	TS Table 4-1
+14%	MHR Table 3-2
+15%	MHR Table 3-2
+28%	MHR Table 3-2
+19%	MHR Table 3-2
+9%	MHR Table 3-2
+7%	MHR Table 3-2
+17%	MHR Table 3-2
+8%	MHR Table 3-2

(a) Relative to optimum moisture content determined in accordance with ASTM D1557.

The data in Tables 3-1 and 3-2 are plotted on Figure 3-2. These data are plotted along a line corresponding to 75% relative density solely for convenience to show these data on the same graph:

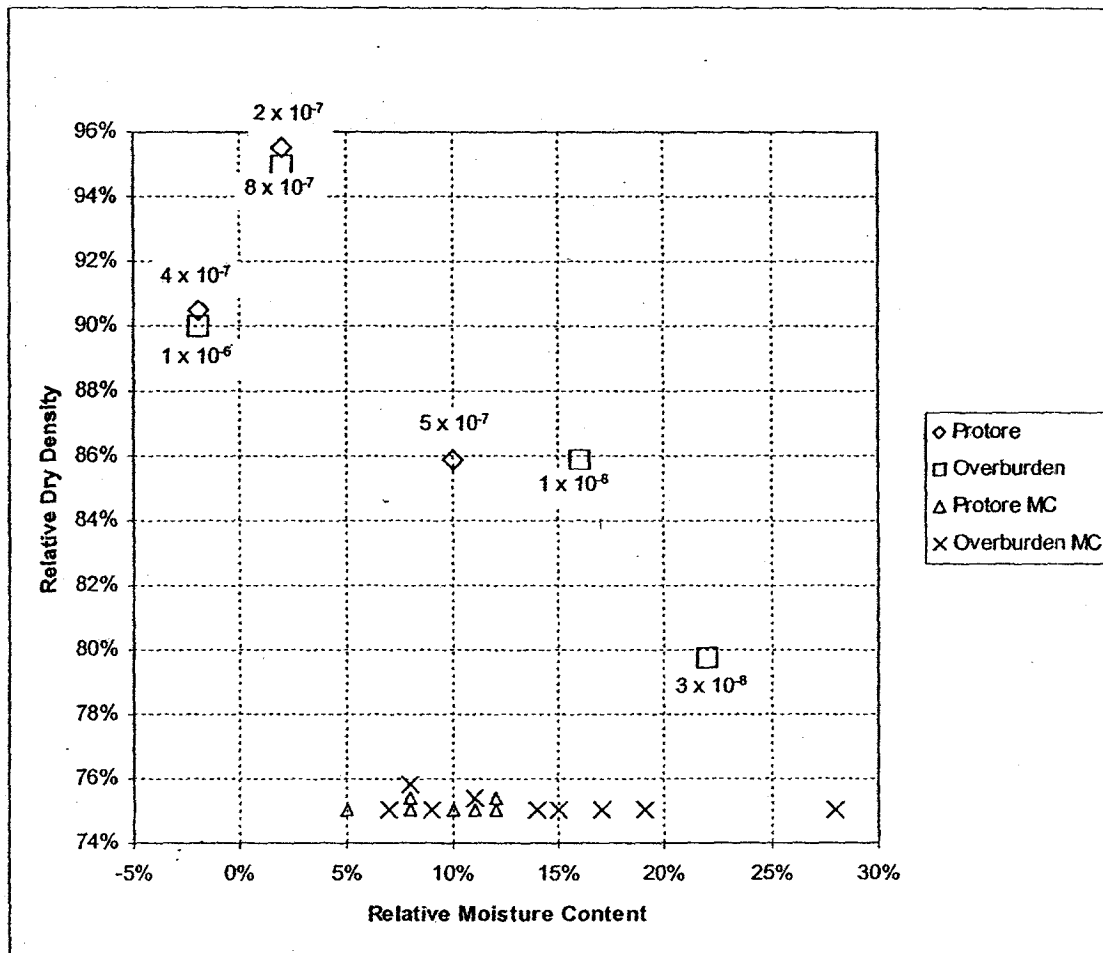


Figure 3-2. Existing Permeability, Compaction, and Moisture Content Data

3.6.4 Sampling and Analysis Program

The Haul Road area requires additional geotechnical characterization for design purposes. Bulk soil samples will be collected from the Haul Road at three locations, near each end and in the center. As part of this process, test pits will be excavated through the Haul Road into the underlying soils to determine the thickness of the Haul Road and the nature of the subgrade soils. Test pits will be terminated when firm native soil or rock is encountered or three feet below the base of the Haul Road, whichever is less.

3.6.5 Study Boundaries

This data need applies to "clay-like" soils that will form the upper portion of the consolidated stockpile. There is a large volume of clay-like material in the protore and overburden stockpiles (557,000 cy; MHR Table 3-1) which has been demonstrated to meet the permeability requirement. This material occurs at the lower elevations of each stockpile (MHR Figures 3-1 through 3-6), and consequently the soil placement sequence will be defined as follows in order to ensure that the clay-like soil is placed in the upper part of the consolidated stockpile:

- First phase of soil placement: off-pile areas, Lucky Lass Stockpile local areas, upper coarser-grained layers of overburden stockpile, and that portion of the protore stockpile to be removed.
- Second phase of soil placement: remaining portion of protore stockpile to be removed and remainder of overburden stockpile.

At the present time, the only soil removal area that is not adequately characterized for design purposes is the Haul Road. The approach for determining the removal sequence for this material is described in the following decision rule.

3.6.6 Decision Rule

Index properties for materials that hydraulic conductivity testing indicated had acceptable permeability are summarized in Table 3.3.

The properties in Table 3-3 typically correlate with permeability. Soils from the Haul Road will be sampled and tested for percent fines (ASTM D1140) and Atterberg limits (ASTM D4318). If the results of these tests fall within the range of data presented in Table 3-3, or exhibit higher plasticity and fines content, the soil may be placed at any location in the consolidated stockpile, and consequently, may be removed at any time during remedial action.

Table 3-3. Geotechnical Index Properties

Percent Fines^(a)	Liquid Limit	Plastic Limit	Plasticity Index	Reference
Protore Stockpile				
39	69	21	48	TS Table 4-1
Overburden Stockpile				
39	73	23	50	TS Table 4-1
Test Pads				
77	90	33	57	MHR Table 3-2
58	75	29	46	MHR Table 3-2
52	69	33	36	MHR Table 3-2

(a) Percentage of material by dry weight passing the U.S. #200 sieve.

If the index test results are below the ranges in Table 3-3, the hydraulic conductivity of the soil will be tested to determine if it meets the target permeability (ASTM D5084). If the Haul Road soil meets the target permeability value, it may be placed at any location in the consolidated stockpile. If this soil does not meet the permeability requirement, then the following options are available:

- If the subgrade below the Haul Road is capable of supporting heavy earthmoving equipment such as scrapers, then the Haul Road may be removed as part of the initial soil consolidation described previously.
- If the subgrade is not suitable for heavy traffic (e.g., thick layers of organic material), then the construction contractor may be required to sequence his earthwork operations so as to place the Haul Road soil in the consolidated stockpile beneath soil that meets the target permeability requirement.

In all cases, compaction testing (ASTM D1557) will be performed to provide data for preparing specifications.

3.6.7 Decision Error Limits

Index properties, compaction, and if necessary, permeability, will be measured by a qualified laboratory using ASTM standard methods. This will ensure accuracy within ASTM limits. A minimum of three tests of each type will be performed to account for natural variability; the average of the test results will be used for the analysis, unless the design engineer determines that additional conservatism is necessary.

3.7 **Potential Borrow Areas – Topsoil and Cover Soil Volumes and Properties**

3.7.1 Problem Statement

What is the available volume of topsoil and/or cover soil in potential borrow areas?

What are the handling characteristics (cohesiveness, weather susceptibility, etc.) of these soils?

3.7.2 Identification of Decision

The decision is whether the potential borrow areas contain the required volume of topsoil and cover soil with appropriate soil properties. If the borrow areas contain more than is needed, then the detailed design will include a development sequence so that disturbed areas and haul distances are minimized. If the borrow areas do not contain sufficient material, additional areas will be identified for investigation.

In addition, any restrictions or conditions required for placement of the borrow soils need to be identified for use in preparing the technical specifications.

3.7.3 Sampling and Analysis Program

Test pits will be excavated at a frequency of about 2 per acre. This will result in a minimum of 8 pits in the Hillside Area and 12 pits in the Clear Cut Area, shown on Drawing 3 in Appendix J. The Lucky Lass Stockpile will also be investigated to allow consideration of using soils from this stockpile for cover soil on the consolidated stockpile. At the Lucky Lass Stockpile, 12 test pits will be excavated and bulk samples collected for testing.

For additional information on potential topsoil, a minimum of 3 test pits will be excavated in Stockpile Area and the Taper Zone Area (see Drawing 3 in Appendix J), for a total of 6 test pits. These pits will be excavated to about 1 foot below the base of the topsoil layer, estimated to be no more than a few feet thick (see MHR Figures 3-1 through 3-6).

The thicknesses of topsoil and cover soil will be measured each of the test pits in the potential borrow areas. The areas for the volume calculations will be determined from existing topographic maps.

Soil testing will include grain size distribution and plasticity. These characteristics will be determined using ASTM test methods D422 and D4318, respectively.

3.7.4 Study Boundaries

The potential topsoil and cover soil borrow areas are shown on Drawing 3 in Appendix J.

3.7.5 Decision Rule

The pre-conceptual design (Appendix J) suggests that the following approximate volumes will be needed:

- Topsoil – 30,000 cy
- Cover soil – 67,000 cy

The borrow sources will be considered adequate if they can provide these volumes. If the potentially available topsoil volume does not appear to be sufficient, part of the topsoil volume may be met by amending cover soil with imported organic material.

Test data will be reviewed for determining if any placement restrictions or conditions are necessary, based on standard earthworks practice.

3.7.6 Decision Error Limits

Soil thickness will be determined from test pits at a limited number of locations. Standard practices will be used to evaluate the variability between test pits. Unless the variability appears to be unusual relative to residual soil deposits of this type, the average of soil thicknesses measured in the test pits will be assumed to adequately represent site conditions.

The geotechnical tests will be performed by a qualified laboratory using ASTM standard methods. This will ensure accuracy within ASTM limits.

3.8 **Potential Gravel Borrow Area Volumes and Properties**

3.8.1 Problem Statement

What is the available volume of gravel in a potential borrow area?

What is the quality (durability) of the gravel?

Is cover soil also available in the potential borrow area?

3.8.2 Identification of Decision

The decision is whether a potential borrow area contains the required volume of gravel with appropriate properties. Gravel would be obtained by extending a former gravel pit at the north end of the consolidated stockpile. The gravel will be produced from native rock that is highly fractured. Based on visual observations of the former pit wall, the excavated material will have a range of particle sizes. Because specific particle size distributions will be required for various uses of the gravel, it is likely that the excavated material will need to be screened. Information about the particle size distribution will therefore be required to determine the costs for this project element and to estimate the total volume and configuration of the excavation. The required gravel sizes will be determined during the design.

If the excavated material must be screened, the undersize fraction may be suitable as cover soil. This would reduce the area of other borrow sources that must be disturbed. Grain size distribution data will allow an estimate of the volume of this by-product material associated with the required volume of gravel.

Gravel will serve as erosion protection until vegetation becomes sufficiently established. Naturally occurring 3H:1V soil slopes (the maximum proposed design slope) were observed during the June 18, 2003 site visit. These natural slopes were stable, supported stands of natural vegetation comparable to those in flatter areas, and showed no signs of erosion. Hence, the gravel will not need to be a permanent erosion control measure, but will only be relied upon for the first few years after remedial activities have been completed. In this context, the gravel should be sufficiently durable so that it does not degrade significantly over about 20 years.

3.8.3 Sampling and Analysis Program

For evaluating gravel size distribution and obtaining samples for durability testing, three (3) boreholes will be drilled in the Expanded Gravel Borrow Area shown on Drawing 4 in Appendix J. If the actual rock conditions appear to vary significantly, the number of boreholes may be increased.

The boreholes will be located in a uniform distribution throughout the potential borrow area, subject to local access and other factors.

The boreholes will be drilled to approximately 50 ft below the existing ground surface, which will encompass the entire thickness of material planned for excavation. The holes will be diamond cored using wireline equipment and, at a minimum, double-tube core barrels to provide maximum recovery and minimize disturbance. The core will be logged and placed in core boxes by Golder personnel in accordance with Golder Procedure TP 1.2-2 *Geotechnical Rock Core Logging*. Upon completion, all boreholes will be flagged for location with GPS equipment.

The fracture frequency and spacing in rock cores from exploratory boreholes will be the primary source of data on expected size distribution, supplemented by visual observations of the existing face of the former gravel pit.

Gravel durability will be determined by performing the LA Abrasion Test (ASTM C535) and the Sulfate Soundness Test (ASTM C88).

To determine the thickness and obtain samples of potential cover soil, a total of 6 test pits will be excavated in the study area. Soil testing will include grain size distribution using ASTM test method D422.

3.8.4 Study Boundaries

The potential borrow area is shown on Drawing 4 in Appendix J.

3.8.5 Decision Rule

The pre-conceptual design (Appendix J) suggests that approximately 11,000 cy of gravel will be needed.

For the proposed gravel borrow area, if enough suitable material is identified, the decision on its use will involve comparing the costs of excavating and screening at the site to importing gravel from off-site sources.

The gravel will have acceptable durability if the loss during the LA Abrasion Test is less than 50% and the loss during the Sulfate Soundness Test is not more than 20% after 5 cycles.

3.8.6 Decision Error Limits

Gravel data will be obtained from a limited number of boreholes at specific locations. Standard practices of geologic interpretation will be used to evaluate the variability of the rock between boreholes. The geotechnical tests will be performed by a qualified laboratory using ASTM standard methods. This will ensure accuracy within ASTM limits.

3.9 **Potential Gravel Borrow Area Excavation Method**

3.9.1 Problem Statement

What are potentially suitable excavation methods for gravel?

3.9.2 Identification of Decision

In order to provide the most cost effective construction bids and prepare specifications, it is necessary to know the excavation method for the borrow source. Bedrock that can be ripped with large equipment will have significantly different requirements than rock which requires blasting.

3.9.3 Sampling and Analysis Program

Testing will consist of determining the seismic (p-wave) velocity of the bedrock. Approximately 800 feet of seismic refraction line will be run within the footprint of the Expanded Gravel Borrow Area shown on Drawing 4 in Appendix J. The number, length, and orientation of the lines will depend on initial field results. Geophone spacing will be sufficient to penetrate to a depth of about 50 feet. Field activities will be performed by Golder personnel in accordance with Golder Procedure TP 1.1-14 *Land Seismic Refraction Survey* (in Appendix I). The results of this activity will also be used to correlate geologic conditions between the boreholes.

3.9.4 Study Boundaries

The potential borrow area is shown on Drawing 4 in Appendix J.

3.9.5 Decision Rule

Rippability will be determined by the use of standard tables from earthworks equipment manufacturers, supplemented by geotechnical interpretation. Typically, seismic velocities of 6,000 ft/sec or less indicate rippable material. Velocities greater than 8,000 ft/sec will indicate that blasting is probably required.

3.9.6 Decision Error Limits

The accuracy of seismic velocity measurements depends on a number of site-specific factors and is difficult to quantify. For this study, the results will be evaluated in conjunction with other geologic and geotechnical information to estimate the accuracy. If the seismic velocities are in the intermediate range, the construction specifications will include the option to use either excavation method.

3.10 COCs in Potential Borrow Materials

3.10.1 Problem Statement

Are COCs in the borrow soils (topsoil, cover soil, and gravel) above cleanup levels?

3.10.2 Identification of Decision

Borrow materials should not contain COCs above cleanup levels for the White King stockpiles.

3.10.3 Sampling and Analysis Program

A representative sample will be collected from each of the test pits and boreholes in each of the potential borrow areas.

Chemical screening tests will be performed on cover soil materials for the indicator parameters arsenic and Ra-226. Details of sampling procedures and analytic methods are included in the QAPP (Appendix F).

3.10.4 Study Boundaries

The potential borrow areas are shown on Drawings 3 and 4 in Appendix J.

3.10.5 Decision Rule

Cleanup levels in the ROD are 442 mg/kg for arsenic and 6.8 pCi/g for Ra-226.

3.10.6 Decision Error Limits

Error limits are those associated with the pertinent EPA test procedures listed in the QAPP.

3.11 Bedrock Depth Upslope of Consolidated Stockpile

3.11.1 Problem Statement

What is the depth to competent (unweathered) bedrock immediately upslope of the consolidated stockpile margin? This information is required to design a ditch, trench, or other feature to intercept groundwater flow along the soil-bedrock interface, thereby reducing potential seepage into the consolidated stockpile.

3.11.2 Identification of Decision

The decision is the type of interceptor to be constructed.

3.11.3 Sampling and Analysis Program

The key inputs to the decision that need to be evaluated in the field are the depth to bedrock and the excavation characteristics of the overlying materials.

Test pits will be excavated to refusal to identify the top of bedrock. Test pits will be located at approximately 100-ft intervals along the western margin of the proposed consolidated stockpile. This activity will be performed in conjunction with evaluation of the Hillside Area borrow source; where appropriate, the same test pit will be used for both purposes.

3.11.4 Study Boundaries

The study area will be the hillside immediately upslope of the consolidated stockpile, as shown on Drawing 1 in Appendix J.

3.11.5 Decision Rule

The decision as to the type of interceptor will be made during the remedial design on the basis of technical feasibility, effectiveness, and cost.

3.11.6 Decision Error Limits

Decision error limits are not applicable to this data need.

3.12 **Bedrock Permeability**

3.12.1 Problem Statement

What is the potential for groundwater seepage into the consolidated stockpile from upslope areas?

3.12.2 Identification of Decision

The decision will be whether or not it is necessary to further consider the effects of groundwater from areas upslope of the consolidated stockpile on COC release.

3.12.3 Sampling and Analysis Program

The key decision inputs will be:

- Depth to bedrock (see Section 3.11)
- Permeability of the bedrock adjacent to the consolidated stockpile.

An estimate of the mass permeability of the basalt bedrock will be required. This parameter will be determined by performing slug tests in existing boreholes upslope of the protore stockpile. This testing will be performed in accordance with Golder Technical Procedure TP 1.2-17 *Rising Head Slug Test* (in Appendix I).

3.12.4 Study Boundaries

The study area will be the hillside immediately upslope of the consolidated stockpile, as shown on Drawing 1 in Appendix J.

3.12.5 Decision Rule

Based on existing data, the in-place permeability of the stockpiled soils can be assumed to be 1×10^{-7} cm/sec or less. If the permeability of the bedrock adjacent to the consolidated stockpile is higher than this value, then groundwater will tend to flow preferentially through the bedrock, and the potential for significant infiltration into the stockpile will be negligible.

3.12.6 Decision Error Limits

Test error limits are discussed in Golder Technical Procedure TP 1.2-17 *Rising Head Slug Test* (in Appendix I).

3.13 **White King Pond Highwall Seeps**

A seep survey will be performed on the "highwall" of the White King Pond, to document the occurrence and nature of the seeps, in order to determine the need for mitigation. Field measurements will consist of measuring pH with a portable meter, and estimating the flow rate with "stopwatch and bucket" or other simple methods. Photographs of seeps will be taken to document conditions. Flow in adjacent diversion ditches, which might be contributing to seeps, will also be observed. The seep

investigation will be performed in early summer, as some seeps have been observed to dry up in later parts of the year. A follow-up survey will be performed in late summer or early fall to identify any seeps that persist throughout the year. Seep locations will be recorded on a topographic map of the site and documented photographically.

4.0 REFERENCES

EPA, 2001. *White King / Lucky Lass Superfund Site Record of Decision*, Office of Environmental Cleanup, EPA Region 10, Seattle, Washington, September 2001.

Weston, Roy F., Inc., 1997. *Final Remedial Investigation Report, White King / Lucky Lass Mines Site, Lakeview, Oregon*, Kerr-McGee Corporation, Oklahoma City, Oklahoma, August 25, 1997.

Weston, Roy F., Inc., 1999a. *Final Feasibility Study, White King / Lucky Lass Mines Site, Lakeview, Oregon*, Kerr-McGee Corporation, Oklahoma City, Oklahoma, August 27, 1999.

Weston, Roy F., Inc., 1999b. *White King Pond Neutralization Report*, Kerr-McGee Corporation, Oklahoma City, Oklahoma.

ASTM Standards:

C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

D422 Standard Test Method for Particle-Size Analysis of Soils

D1140 Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-um) Sieve

D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort

D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D5084 Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter